

## **SPECIFICATION**

TO ALL WHOM IT MAY CONCERN:

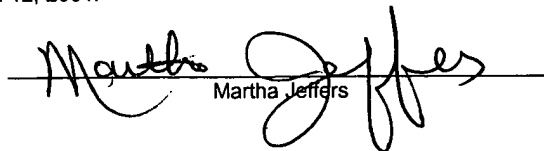
BE IT KNOWN that I, Spencer M. Nimberger, have invented new and useful improvements in a

### **BREAKAWAY COUPLING WITH FLAPPER VALVE**

of which the following is a specification:

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I hereby certify that this correspondence and all referenced enclosures are being deposited by me with the United States Postal Service as Express Mail with Receipt No. EV 317506602 US in an envelope addressed to the Assistant Commissioner of Patents, BOX NEW PATENT APP., P.O. Box 1450, Alexandria, VA 22313-1450 on March 12, 2004.

  
Martha Jeffers

## BREAKAWAY COUPLING WITH FLAPPER VALVE

### **Field of the Invention**

The invention relates to a breakaway coupling with improved reliability and reduced service costs. More particularly, this invention relates to a breakaway coupling particularly suitable for positioning between a liquid anhydrous-ammonia nurse tank and an applicator for applying the liquid anhydrous ammonia to the field. Upon separation, each coupling half is automatically sealed for retaining the liquid anhydrous ammonia in the flow lines extending to and from the coupling.

### **Background of the Invention**

Flow line systems which transport potentially dangerous fluids, such as anhydrous ammonia, commonly include a separable connection for emergency interruption of the flow line which extends between a stationary vessel and a potentially portable vessel, such as a transport vehicle. Occasionally, the driver of the transport vehicle inadvertently pulls away from the stationary vessel prior to disconnecting the flexible flow line, and the absence of a separable connection may otherwise cause a rupture of the fill line. The monetary loss of fluid from such a rupture is nominal compared to the danger of releasing toxic vapors. The release of anhydrous ammonia may seriously injure the operator, causing blindness, skin burns, or loss of smell. For other potentially dangerous fluids, such as propane and liquid petroleum gas, the release of the fluid may cause adverse environmental consequences to the filling station site or create a fire hazard. One type of improved breakaway connection, marketed as TRIPOD (TM) coupling, is disclosed in U.S. Pat. Nos. 5,228,474 and 5,320,133. The TRIPOD coupling is particularly suitable for positioning between a stationary filling platform and a transport vehicle.

In a typical anhydrous ammonia application system, a nurse tank, which may be periodically filled by the above-described transport vehicle, is attached to

5 anhydrous ammonia applicator with a mechanical hitch. Each end of the hose which connects the nurse tank and an applicator includes a shutoff valve. A breakaway coupling is provided between the shutoff valves, and is designed so that it will uncouple with a pull force sufficiently small to not damage the nurse tank. The primary purpose of the breakaway coupling is both to separate or breakaway and to  
10 shut off the flow of ammonia in the event of separation of the applicator and nurse tank at the mechanical hitch.

The PIONEER (TM) breakaway coupling, used in anhydrous ammonia application systems, is distributed by Parker Hannifin Corporation. When disconnected, poppet valves in each half of the coupling are closed by respective  
15 valve springs, thereby stopping the flow of ammonia to the atmosphere. When the coupling is either fully connected or fully disconnected, a spring positions a sleeve to prevent locking balls from rising up out of their ball holes. When fully connected, the poppet valves in both coupling halves are open to allow ammonia flow. When the axial pull on the male coupling half exceeds the force of the sleeve spring, the  
20 coupling male half will pull out of the socket. The poppet valve then springs closed to stop the discharge of anhydrous ammonia from the flexible flow lines. The PIONEER coupler has been manufactured with stainless steel components which alleviated many of the problems it had with corrosion which led to failures in operation. There are, however, other characteristics inherent to this design.

25 The first and most significant problem with the PIONEER coupler is the flow restriction caused by the spring loaded poppets positioned in the flow stream. In anhydrous ammonia applications, the flow rate achievable through the breakaway coupler is of paramount importance. In situations where a farmer desires to put a certain amount of anhydrous ammonia per acre on a field, the time required to do  
30 the job is directly affected by the flow rate the application system can deliver. Anhydrous ammonia is typically not pumped to the application system but rather is driven solely by the fluid pressure of the anhydrous ammonia nurse (supply) tank. The pressure in the tank is a function of the ambient temperature, and when the

5 temperature is relatively cool the tank pressure will be low. It is generally desirable to apply anhydrous ammonia when the ground is cool so as to improve absorption into the soil and minimize loss due to evaporation.

When the anhydrous ammonia meets a restriction in the application system, a pressure drop occurs, decreasing the maximum deliverable flow rate of the system.

10 It is generally recognized that the breakaway coupler causes the most severe restriction in the system. When a farmer has several thousand acres to fertilize and there is a short time window where the soil temperature and moisture content is ideal for anhydrous application, it makes a big difference whether the application instrument can travel at, for example, 7 miles per hour and still achieve the desired  
15 application rate, or whether the speed must be reduced to, for example, 4 miles per hour because the system cannot deliver the flow required to run at 7 miles per hour. The difference can amount to additional days required to do the job. Because of these factors, a high flow breakaway coupler has always been desired.

A further problem with existing locking ball couplers is the difficulty of  
20 manually coupling or uncoupling them. This is routinely required for periodic safety inspection of the coupler or removal of the application hose for off-season storage. Existing devices require the user to muscle the coupler by hand to compress the main latch spring which typically requires from 200 to 300 pounds of force. The manual application of that level of force to a flexibly mounted coupler is at best  
25 difficult and at worst dangerous to do.

Other devices of interest are disclosed in U.S. Pats. 5,947,142, 5,699,822, 5,419,354, and 4,090,524. U.S. Pat. 5,947,142 discloses an improved breakaway coupling utilizing poppet-type valves. U.S. Pat 5,699,822 discloses a breakaway coupling device using shear pins to couple male and female members and optionally  
30 including flapper-type valves. U.S. Pat 5,419,354 discloses a frangible connector apparatus for controlling a fluid passage, providing at least one sliding gate movable transversely to the fluid passage. U.S. Pat. 4,090,524 discloses a valved fitting for handling flowing fluids having another valved fitting or conduit attached thereto

5 wherein a frangible interconnection is utilized. Upon the frangible connection  
fracturing, such action is sensed by valve operating means for closing the valve  
against fluid flow producing a self-sealing fitting. A flapper valve is utilized to seal  
the valve passage with the goal of maximizing flow characteristics with a minimum of  
resistance during fluid flow.

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### **Summary of the Invention**

A breakaway coupler is disclosed for coupling an upstream hose with a  
downstream hose to pass fluid therebetween when coupled and closing flow when  
uncoupled. An upstream housing is securable to the upstream hose. An upstream  
15 coupling member is secured to the upstream housing and has a flow passage for  
fluid communication with the upstream hose. A downstream housing is securable to  
the downstream hose. A downstream coupling member is secured to the  
downstream housing and has a flow passage for fluid communication with the  
downstream hose.

20 One or more locking balls or other locking members are preferably carried by  
the downstream coupling member. One or more receiving members or outwardly  
facing locking recesses are carried on the upstream coupling member. The one or  
more locking balls are movable radially inward into the one or more outwardly facing  
locking recesses to lock the upstream and downstream coupling members. A trigger  
25 member is positioned radially outward of the one or more locking balls and has one  
or more inwardly facing unlocking recesses. A trigger spring axially biases the  
downstream housing from the trigger member to position the locking member at  
least partially downstream from the one or more inwardly facing unlocking recesses  
to maintain locking of the upstream and downstream coupling members.

30 An upstream flapper is pivotally secured with respect to the upstream housing  
and is movable between an open and closed position to open and close flow through  
the upstream coupling member. The upstream flapper has a first engagement  
surface and a second engagement surface angled with respect to the first

5 engagement surface. A pushrod is axially movable in response to engagement by  
the downstream coupling member. The pushrod has an end surface engageable  
with the first engagement surface for moving the upstream flapper to the open  
position and engageable with the second engagement surface to retain the  
upstream flapper in the open position. An outwardly facing pry recess is preferably  
10 included on the downstream coupling member, spaced between the downstream  
housing and the upstream housing, such that a tool inserted into the pry recess is  
leverageable to move the downstream coupling member to unlock the breakaway  
coupler.

This summary is intended to give a general description of one preferred  
15 embodiment of the invention, without limiting the invention. The foregoing aspects of  
the invention will be more fully understood and better appreciated by reference to  
the following description and drawings.

5     **Description of the Drawings**

Figure 1 shows a perspective view of the breakaway coupler with the downstream housing attached to a frame with a mounting bracket.

Figure 2 shows the breakaway coupler wherein the upstream coupling member is unlocked and axially spaced from the downstream coupling member.

10     Figure 3 shows the breakaway coupler wherein the upstream coupling member is locked to the downstream coupling member.

Figure 4 shows a sectional view 4-4 from Figure 2.

Figure 5 shows an enlarged view wherein the flapper is closed and the pushrod is axially movable to engage the first engagement surface to open the  
15     flapper.

Figure 6 shows an enlarged view with the flapper in the open position, with the pushrod moved axially into engagement with the second engagement surface to retain the flapper in the open position.

Figure 7 shows an enlarged view with the locking ball movable into the  
20     inwardly facing unlocking recess to unlock the upstream and downstream coupling members.

Figure 8 shows a screwdriver inserted into the pry recess prior to leveraging against the trigger member.

Figure 9 shows a screwdriver inserted into the pry recess and leveraged  
25     against the trigger member to align the locking ball with the unlocking recess to unlock the upstream and downstream coupling members.

## 5     **Detailed Description of the Preferred Embodiments**

Figure 1 shows a perspective view of a breakaway coupler 10 for coupling an upstream hose 12 with a downstream hose 14 for passing fluid therebetween when coupled and closing flow when uncoupled. An upstream housing 16 is secured to the upstream hose 12 and a downstream housing 18 is secured to the downstream hose 14. Bracket 15 may be used for mounting the breakaway coupler 10 to a suitable structural support. The upstream hose 12 typically supplies fluid from a portable nurse tank, and the downstream hose 14 may be connected to a fertilizer applicator on a moving farm vehicle.

Figure 2 shows a more detailed view of the breakaway coupler 10 when unlocked. An upstream coupling member 20 is secured to the upstream housing 16 and has a flow passage 21 for fluid communication with the upstream hose (not shown). A downstream coupling member 22 is threadedly secured to the downstream housing 18 and has a flow passage 23 for fluid communication with the downstream hose (not shown). A locking member 24 is carried by the downstream coupling member 22 for selectively locking with the upstream coupling member 20. As shown, a preferred embodiment of the locking member 24 is a plurality of locking balls 24, although other locking members may be used, as discussed below. A receiving member 26, which is preferably the one or more outwardly facing locking recesses 26 shown, is defined by the upstream coupling member 20. The one or more locking balls 24 are radially movable into and out of the one or more locking recesses 26 to respectively lock and unlock the upstream and downstream coupling members 20, 22.

Figure 3 shows the breakaway coupler 10 when locked, with the locking balls 24 radially moved into the locking recesses 26 to lock the upstream and downstream coupling members 20, 22. Seals such as o-ring 27 are provided to seal between the coupling members 20, 22, so that fluid may be reliably passed from the upstream hose 12 to the downstream hose 14. A trigger member 28 is secured to the bracket 15 and is positioned radially outward of the locking balls 24. The trigger member 28



5 has one or more inwardly facing unlocking recesses 30 into which the locking balls 24 are movable when the locking balls 24 are substantially axially aligned with the unlocking recesses 30. As shown, however, a trigger spring 29 axially biases the downstream housing 18 from the trigger member 28 to position the locking balls 24 at least partially downstream from the one or more inwardly facing unlocking  
10 recesses 30 to maintain locking of the upstream and downstream coupling members 20, 22.

Figures 6 and 7 show some of the above features in closer detail. In Figure 6, the coupler 10 is locked, as in Figure 3. The locking ball 24 is sufficiently downstream from the unlocking recess 30 that it cannot be radially moved into the  
15 unlocking recess 30. Rather, the locking ball is maintained at least partially within the outwardly facing locking recess 26, such that the upstream coupling member 20 cannot slide past the locking ball 24, and is effectively locked to the downstream coupling member 22 on which the locking ball 24 is carried.

In Figure 7, the coupler 10 is on the verge of unlocking. A pulling force  
20 transmitted through hose 12 and housing 16 is transferred to the male coupling member 20, then to the female coupling member 22 and the downstream housing 18. The downstream housing 18 is thus forcibly urged slightly upstream against the resistance of the trigger spring 29. Since the downstream housing 18 carries with it the downstream coupling member 22, the locking ball 24 are moved closer to the  
25 unlocking recess 30. The locking ball 24 is now close enough to the unlocking recess 30 that it is free to begin moving radially into the unlocking recess 30 and out of the locking recess 26, so that the upstream coupling member 20 can slide past the locking ball 24 to unlock the coupler 10. The upwardly sloping ends of locking recess 26 desirably urge the locking ball 24 radially outwardly out of the recess 26.

30 Although the spring 29 ensures a reliable locking connection, considerable force is typically required to move the housing 18 as described above, which can be difficult to apply by hand. To alleviate this problem, the invention provides an outwardly facing pry recess 32 detailed in Figures 8 and 9. The pry recess 32 is

5 spaced between the downstream housing 18 and the upstream housing 16, and is closely adjacent an end of the trigger member 28 when the coupling is mated. A screwdriver 34 or other tool inserted into the pry recess is leverageable against the trigger member 28 to move the downstream coupling member 22 with respect to the trigger member 28. During this movement shown between Figures 8 and 9, the  
10 locking ball 24 carries with it the downstream coupling member 22 and the downstream housing 18 to which coupling member 22 is secured. The trigger spring 29 provides resistance to this motion to resist unlocking of the coupler 10. In Figure 9, the locking ball 24 is close enough to the unlocking recess 30 that it is free to begin moving radially into the unlocking recess 30 and radially out of the locking  
15 recess 26, so that the upstream coupling member 20 can slide past the locking ball 24 to unlock the coupler 10. This unlocking motion is conceptually the same as that described above, except that at least some of the force is provided by leveraging the screwdriver 34 to reduce or eliminate the degree of force required by hand. A similar operation may be used to overcome the spring 29 and mate the coupling to a  
20 locking position. The leverage provided by the screwdriver 34 thus makes it easier to lock or unlock the coupler 10.

Referring back to Figures 2 and 3, the breakaway coupler 10 opens flow when locked and closes fluid flow when unlocked. This is a safety precaution for instances where the upstream hose 12 is inadvertently pulled away, such as if the  
25 driver of a tank truck drives away before disconnecting the upstream hose 12. This would create the unlocking motion described above by forcefully pulling on the upstream coupling member, which in turn pulls the downstream coupling member toward the trigger member to separate the coupling. An upstream flapper 40 is pivotally secured at hinge 41 with respect to the upstream housing 16, and is  
30 movable between the closed position of Fig. 2 and the open position of Fig. 3 to open and close flow through the upstream coupling member 20. As shown more closely in Figs. 5-7, the upstream flapper 40 has a first engagement surface 42 and a second engagement surface 43 angled with respect to the first engagement

5 surface 42, preferably at a 90-degree angle. The first and second engagement surfaces 42, 43 are radially spaced from a flapper axis of rotation at hinge 41. A pushrod 44 sealed to upstream housing 16 is axially movable with respect to the upstream housing 16 in response to axial movement of the coupling members. Specifically, as shown, an end 36 of the downstream coupling member 22 preferably  
10 engages the pushrod 44 when the upstream and downstream coupling members 20, 22 are moved together when locking. The pushrod 44 has an end surface 45 engageable with the first engagement surface 43 for moving the upstream flapper 40 to the open position. With first engagement surface 43 so engaged, the flapper 40 is pivoted toward the open position. With the flapper 40 so moved, the end surface 45  
15 of the pushrod 44 is then engageable with the second engagement surface 42 to retain the upstream flapper 40 in the open position. Thus, locking the upstream and downstream coupling members 20, 22 opens the upstream flapper 40 and unlocking the upstream and downstream coupling members 20, 22 allows the upstream flapper 40 to close. The flapper 40 is biased to the closed position with flapper  
20 biasing spring 46.

To facilitate rotation of the flapper 40 in response to axial movement of the pushrod 44, the first and second engagement surfaces preferably intersect at an edge 47. The edge 47 may be a “knife-edge” or a slightly rounded edge, so long as the end surface 45 of pushrod 44 is allowed to transition from first engagement  
25 surface 43 to second engagement surface 42 between locking and unlocking. Furthermore, the first and second engagement surfaces 43, 42 are preferably at 90 degrees from each other, which may correspond to a preferred approximately 90-degree travel of the flapper 40 between open and closed positions.

It is desirable to minimize movement of the flapper 40 prior to fully unlocking  
30 the upstream and downstream coupling members 20, 22. If the flapper 40 were to enter a forceful flow stream before the coupling members 20, 22 were fully unlocked, the flapper 40 could get damaged from the resulting forces. It is therefore important to minimize the amount of axial displacement between the coupling members 20, 22

5 prior to unlocking, thereby minimizing the amount of travel of the pushrod 44 and the corresponding amount of rotation of the flapper 40. Accordingly, the trigger spring 29 preferably biases the downstream housing 18 and thus the downstream coupling member 22 to position the one or more locking balls 24 no more than one ball diameter downstream from the inwardly facing unlocking recesses 30. This limits  
10 travel of the pushrod 44 when unlocking. The pushrod 44 is preferably spring-biased for axially biasing the pushrod 44 away from the second engagement surface to allow the upstream flapper 40 to close. The upstream flapper 40 may alternatively push the pushrod 44 out of the way as it closes. The pushrod 44 is fluidly sealed to upstream housing 16, as shown.

15 Although upstream hose 12 is typically a supply hose and downstream hose 14 is typically a hose for receiving and transporting fluids to a tank, and it is also desirable to close off flow from the downstream hose 14. A downstream flapper 50 may be pivotally secured with respect to the downstream housing 18 and movable between an open and closed position to open and close flow through the  
20 downstream coupling member 22. As shown in Figure 2, the downstream flapper 50 may pivot in such a way that fluid flowing from the upstream hose 12 urges the downstream flapper 50 open. The downstream flapper 50 may be biased to a closed position with another flapper spring 52.

Although the locking members are preferably locking balls 24, they may take  
25 other shapes and forms, such as one or more radially movable locking pins or collet members. The receiving members, although preferably recesses as discussed, may also take other shapes and forms, such as through-holes or flanges.

Although specific embodiments of the invention have been described herein in some detail, this has been done solely for the purposes of explaining the various  
30 aspects of the invention, and is not intended to limit the scope of the invention as defined in the claims which follow. Those skilled in the art will understand that the embodiment shown and described is exemplary, and various other substitutions,

- 5 alterations, and modifications, including but not limited to those design alternatives specifically discussed herein, may be made in the practice of the invention without departing from its scope.